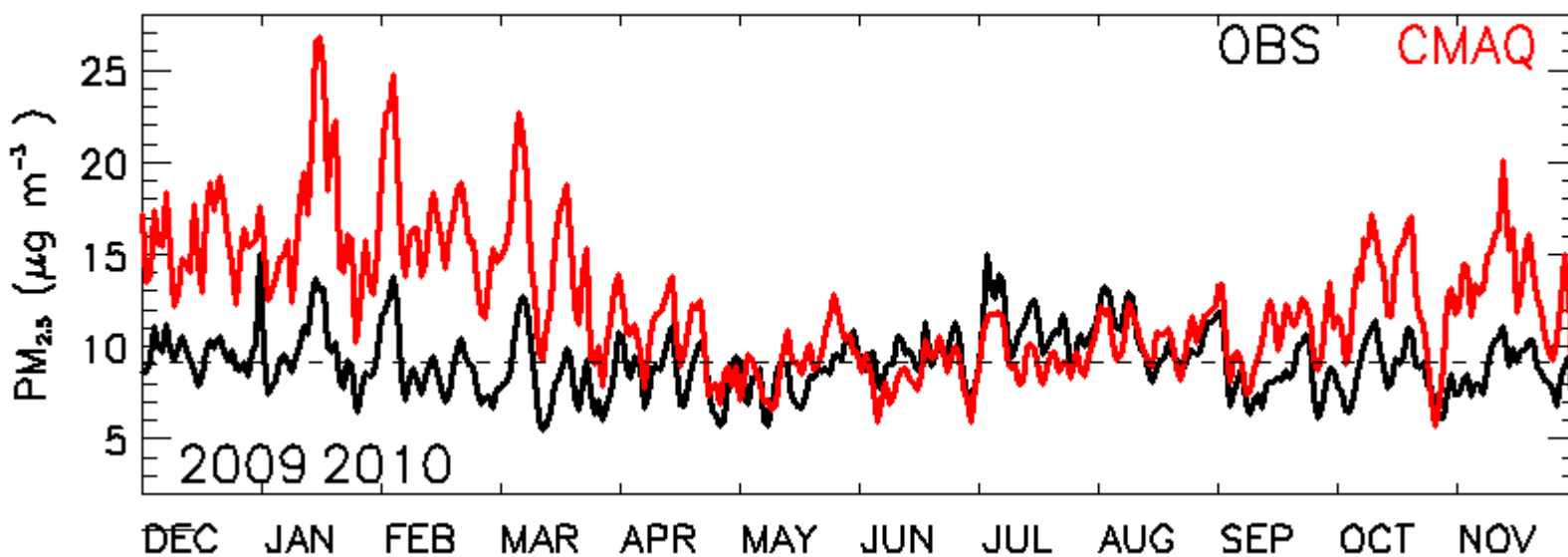


Community Multiscale Air Quality (CMAQ) PM_{2.5} forecast improvements to a Kalman_filter Analog post-processing scheme.

Irina Djalalova^{1,2}
Luca Delle Monache³,
James Wilczak²



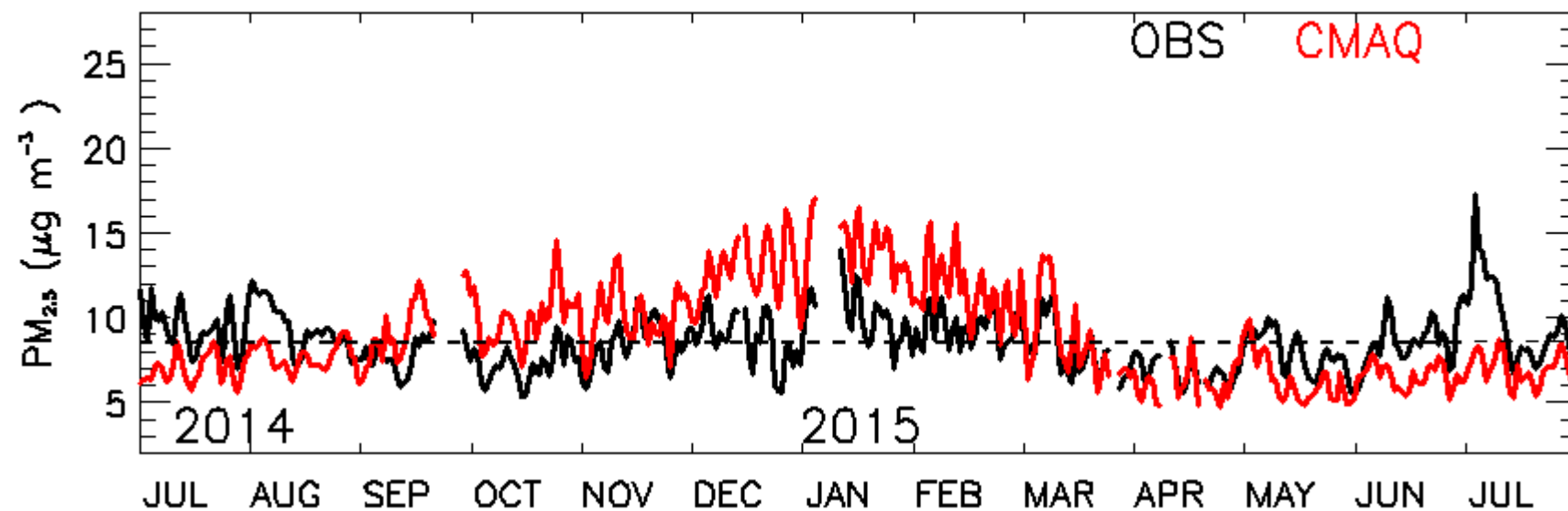
- ¹ *University of Colorado Cooperative Institute for Research in the Environmental Sciences (CIRES), Boulder, Colorado*
- ² *National Oceanic and Atmospheric Administration/Earth Systems Research Laboratory (NOAA), Boulder, Colorado*
- ³ *National Center for Atmospheric Research (NCAR), Boulder, Colorado*

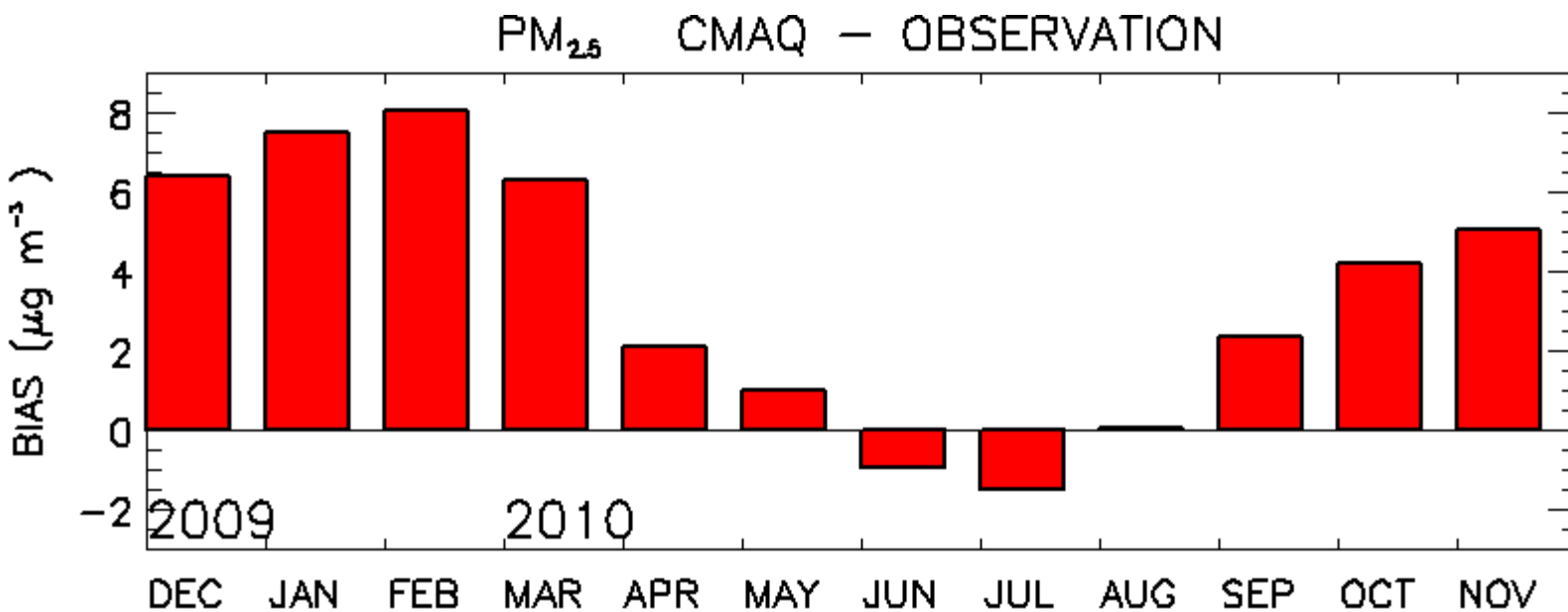


Changes to CMAQ 2010 - 2015

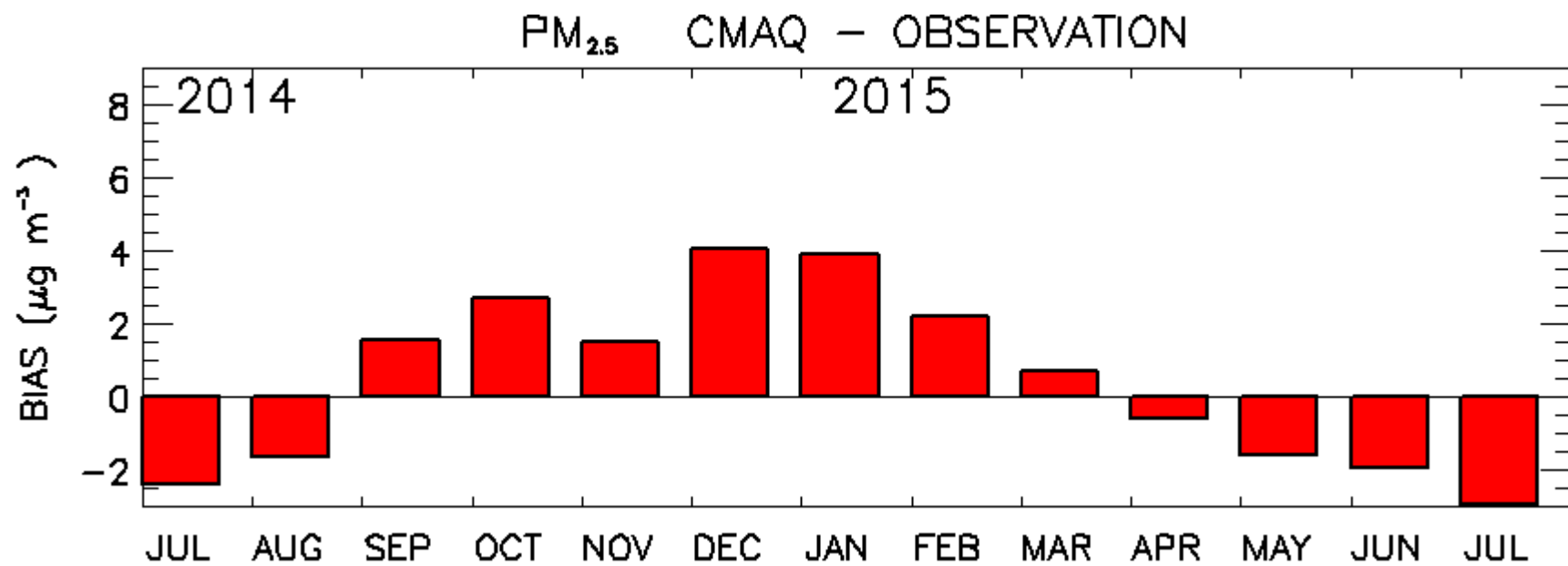
570 AIRNow sites
24-h averages
Correlation = 0.408

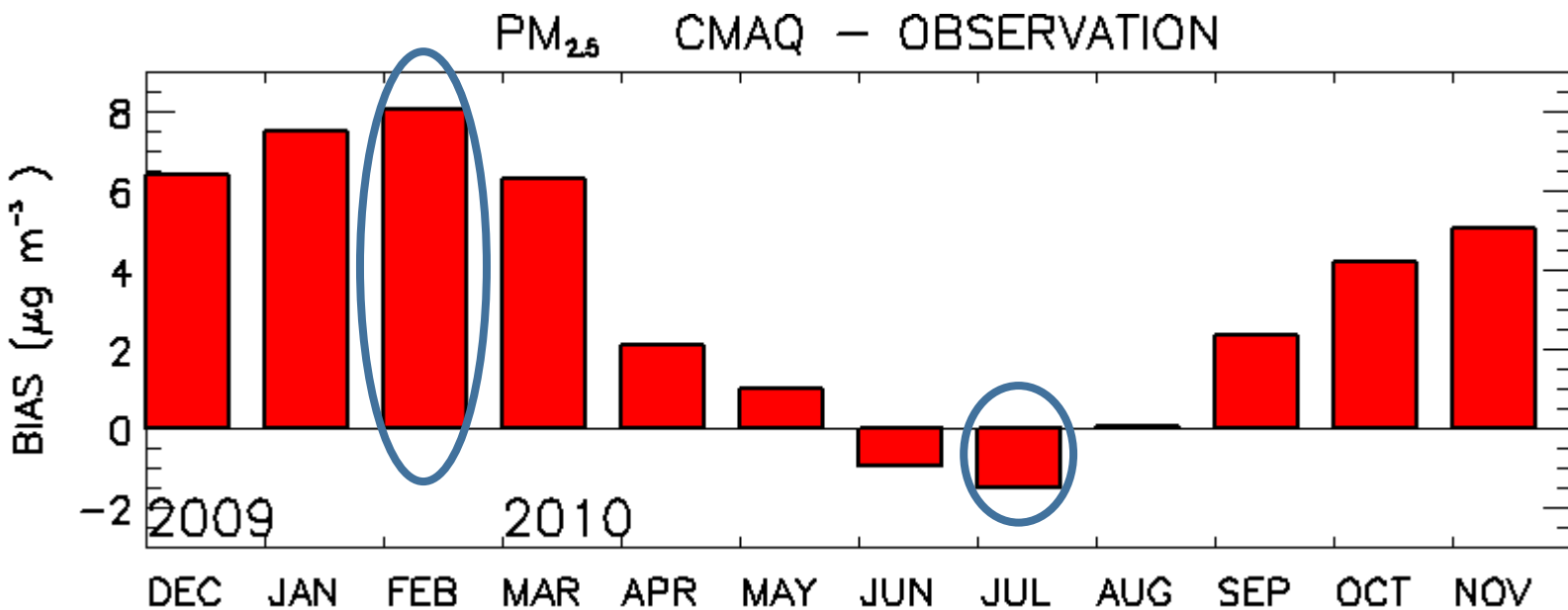
567 AIRNow sites
24-h averages
Correlation = 0.371



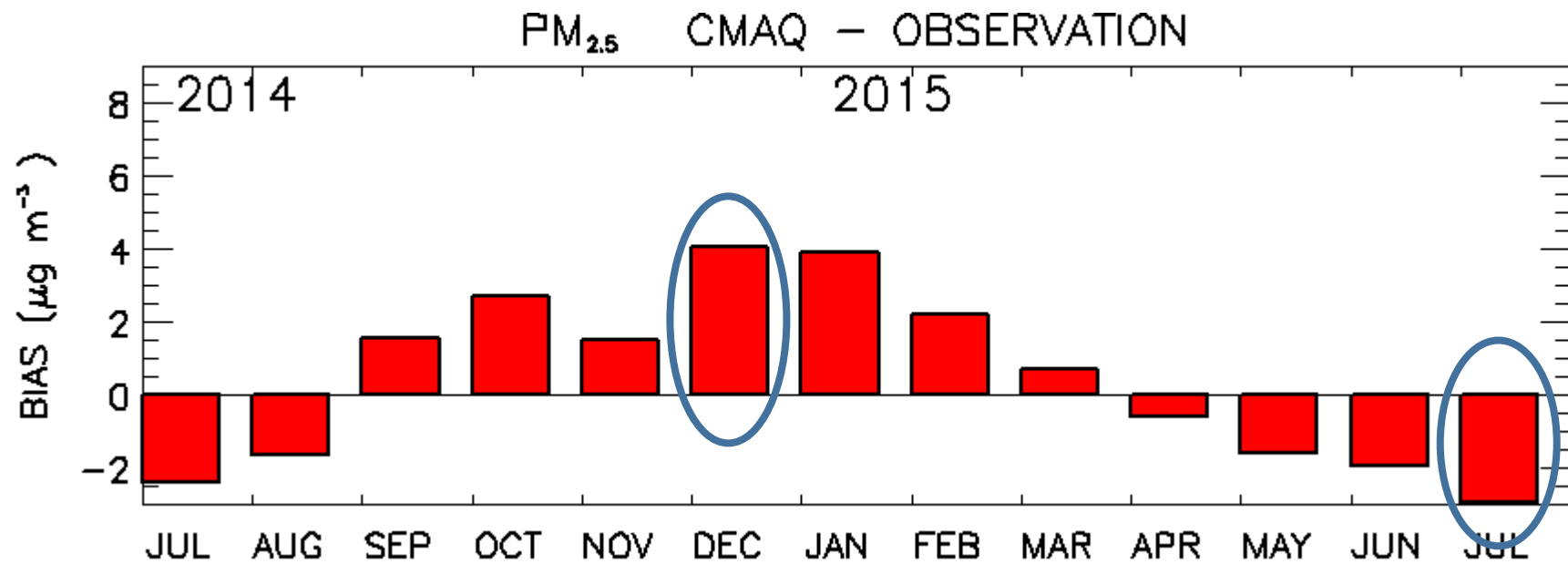


CMAQ Bias
2009-2010
VS
2014-2015

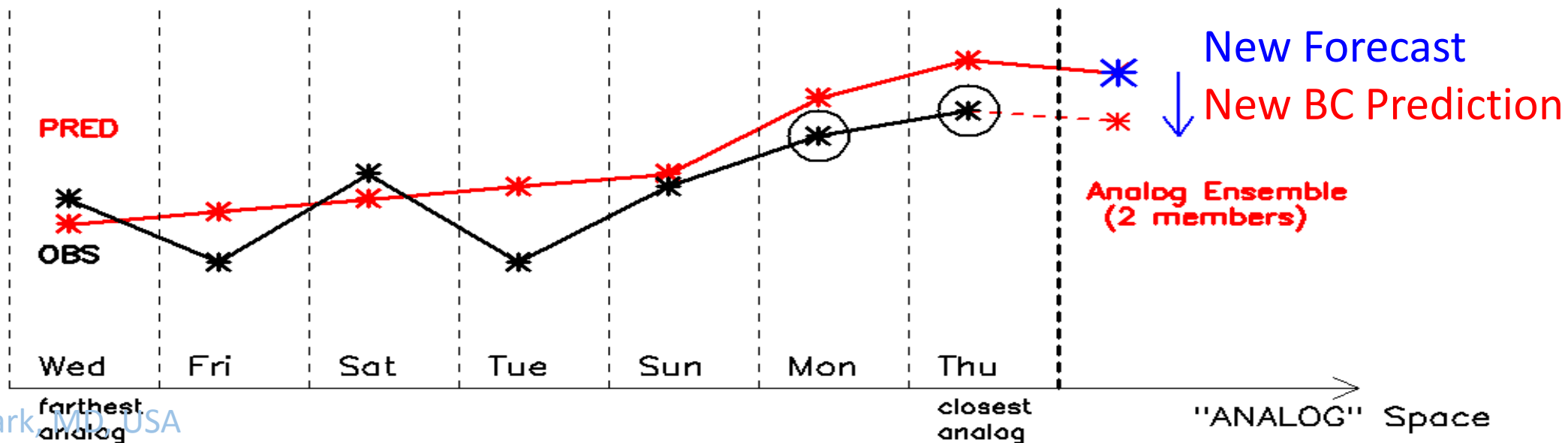
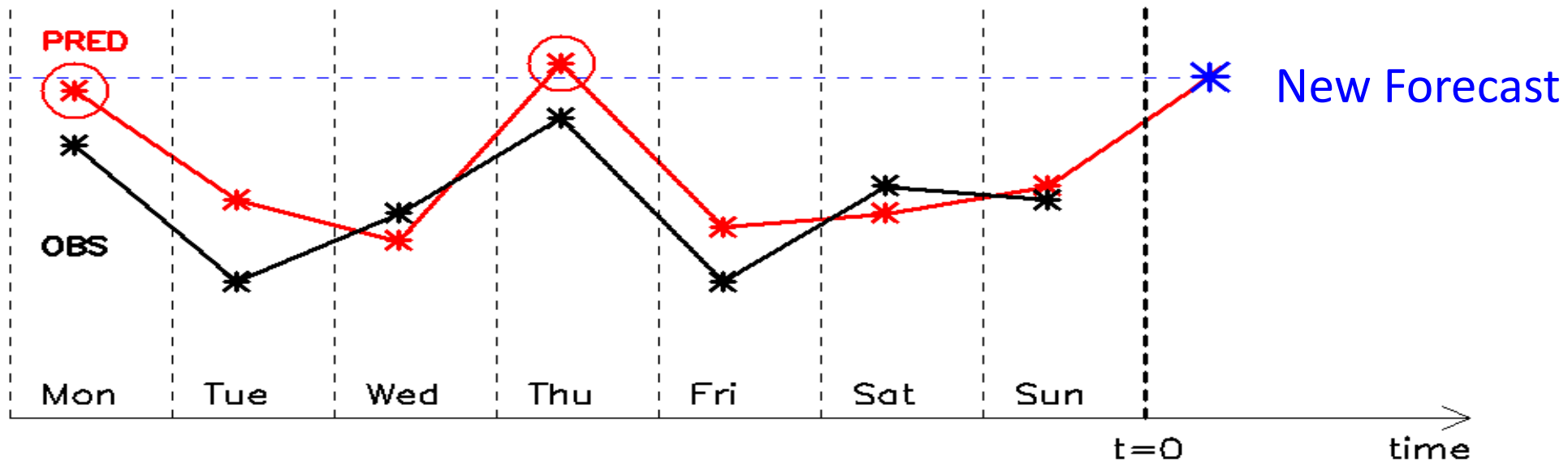




CMAQ Bias
2009-2010
VS
2014-2015

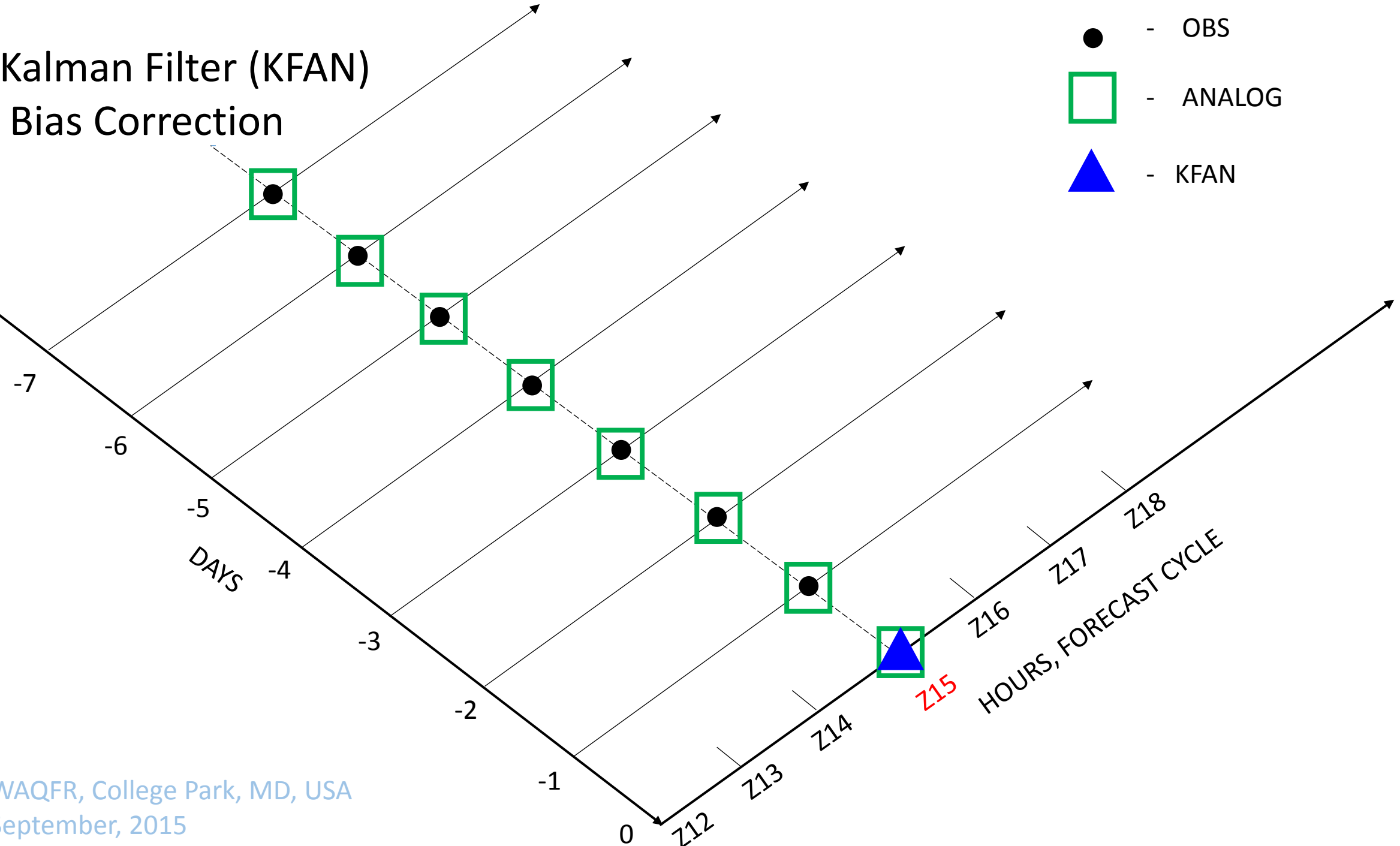


Analog Bias Correction



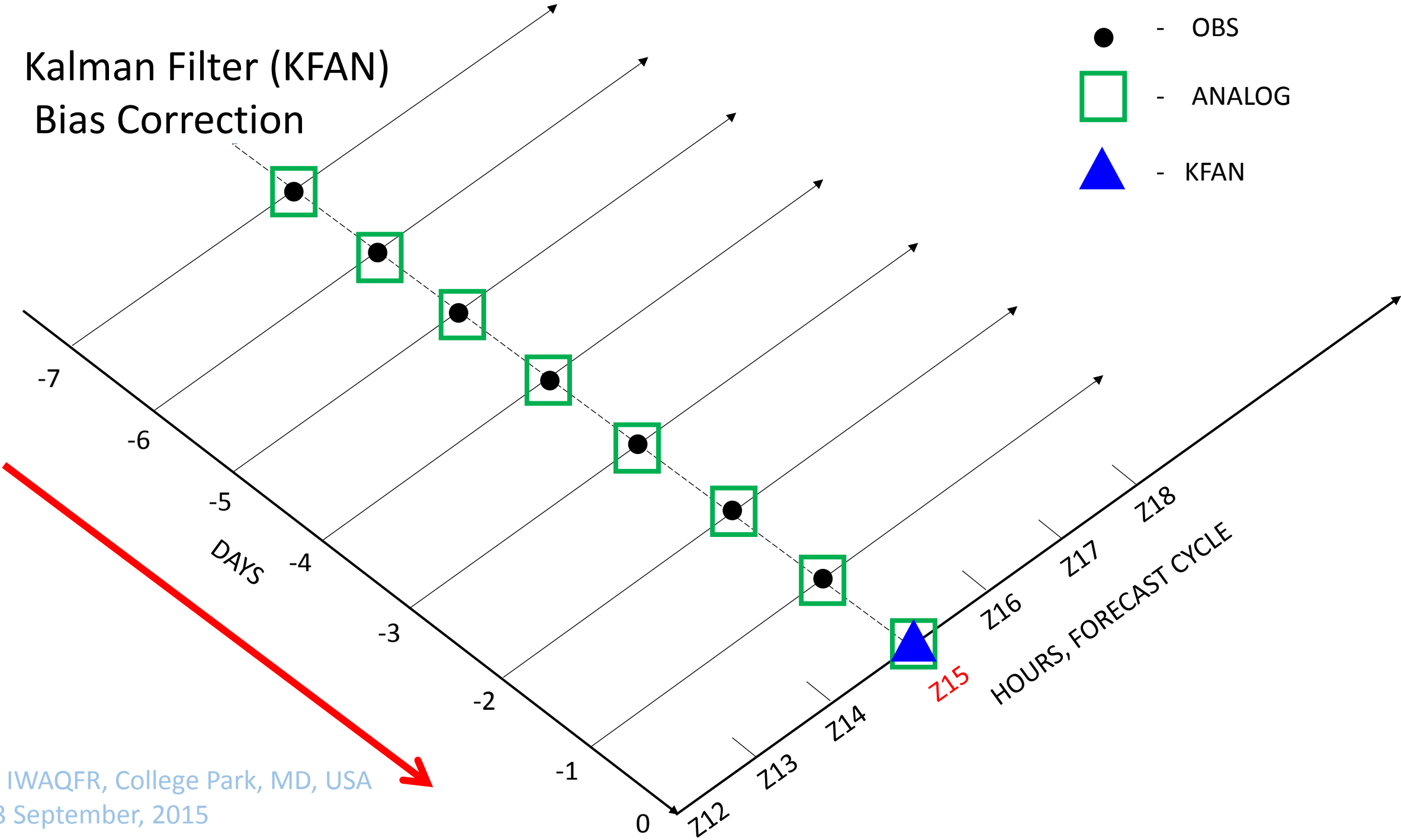
Kalman Filter (KFAN) Bias Correction

- - OBS
- - ANALOG
- ▲ - KFAN



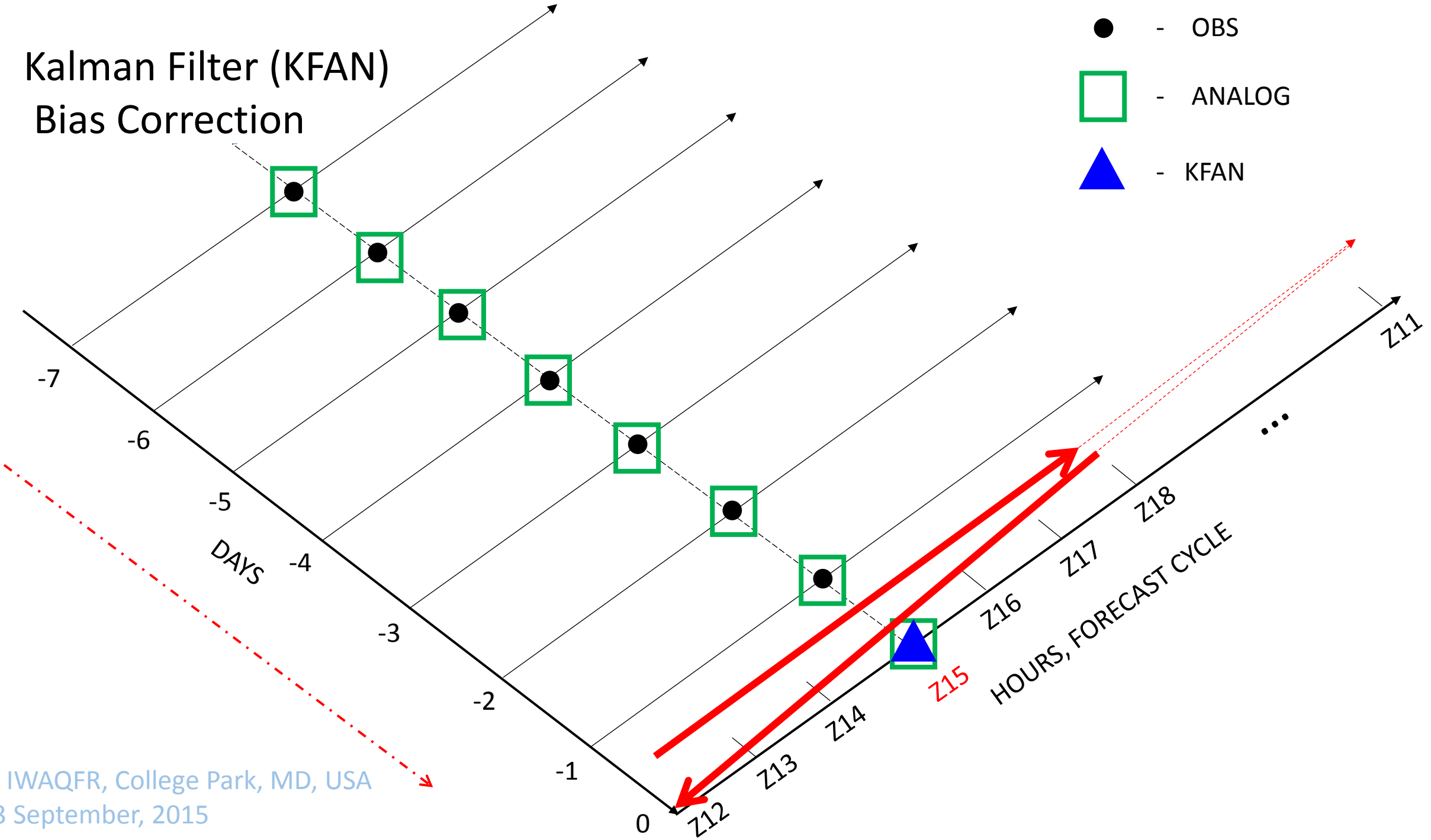
Kalman Filter (KFAN) Bias Correction

- - OBS
- - ANALOG
- ▲ - KFAN

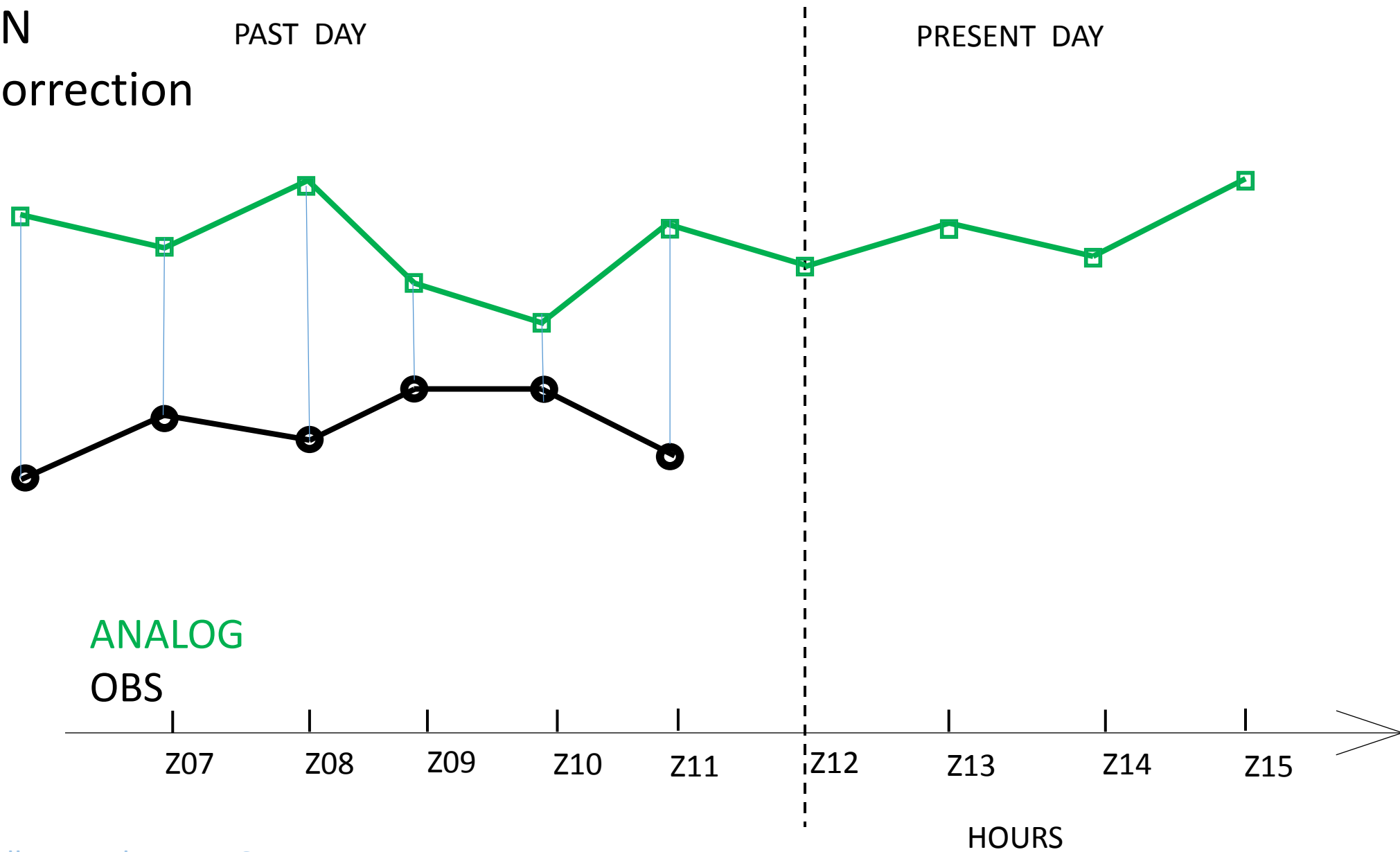


Kalman Filter (KFAN) Bias Correction

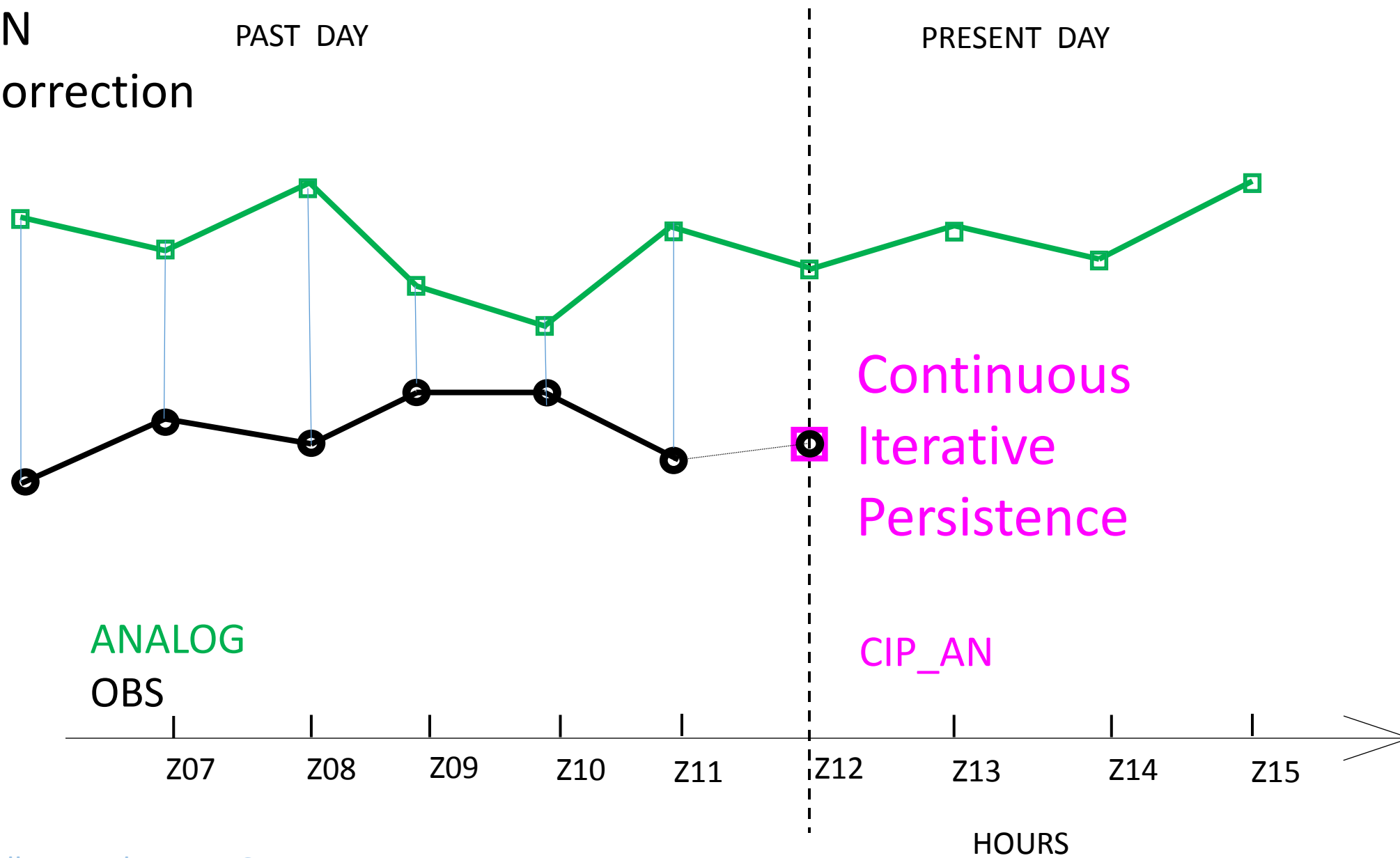
- - OBS
- - ANALOG
- ▲ - KFAN



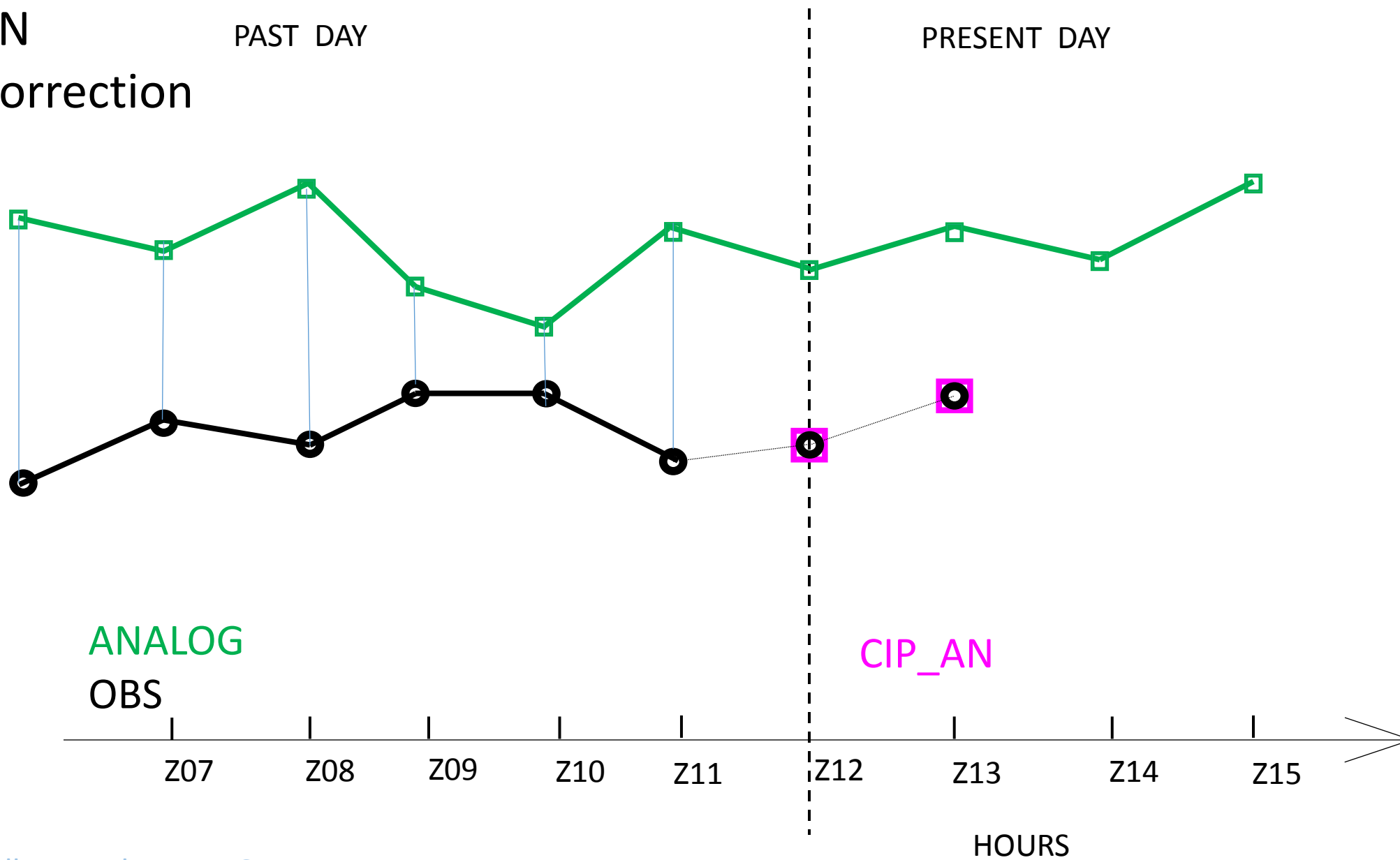
CIP_AN Bias Correction



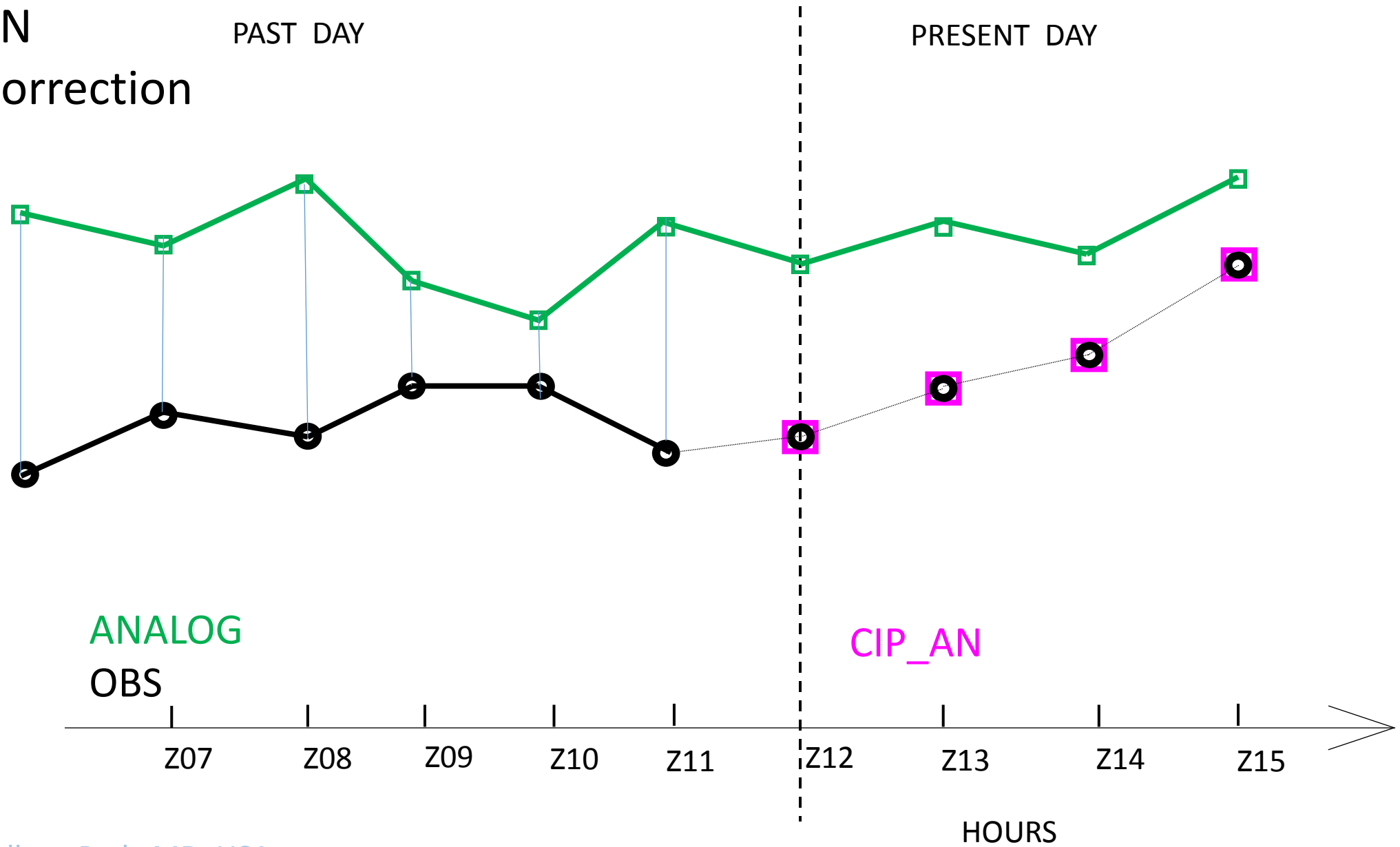
CIP_AN Bias Correction



CIP_AN Bias Correction



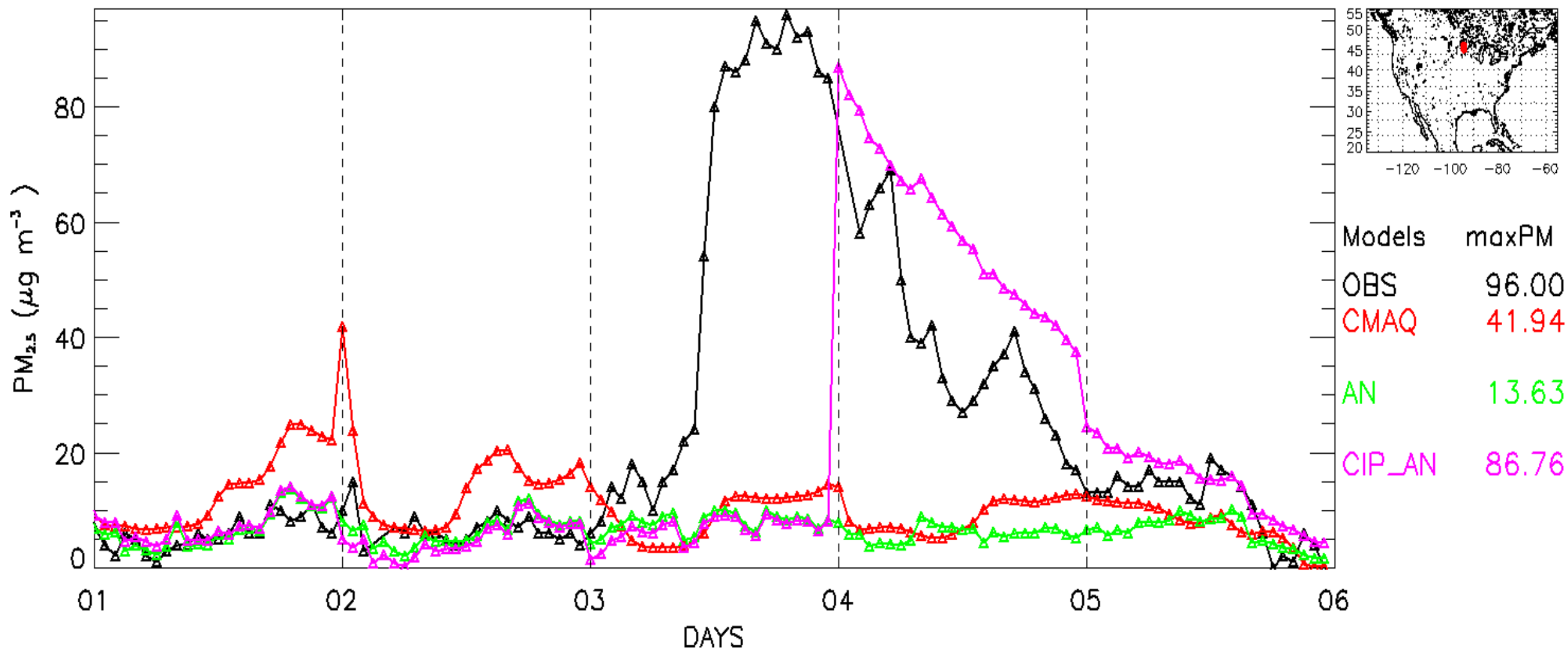
CIP_AN Bias Correction



Time Series CIP AN BiasCorrection

PM_{2.5} JULY 1–5, 2015

site 271453052



RMSE & Correlation

All values of obs PM

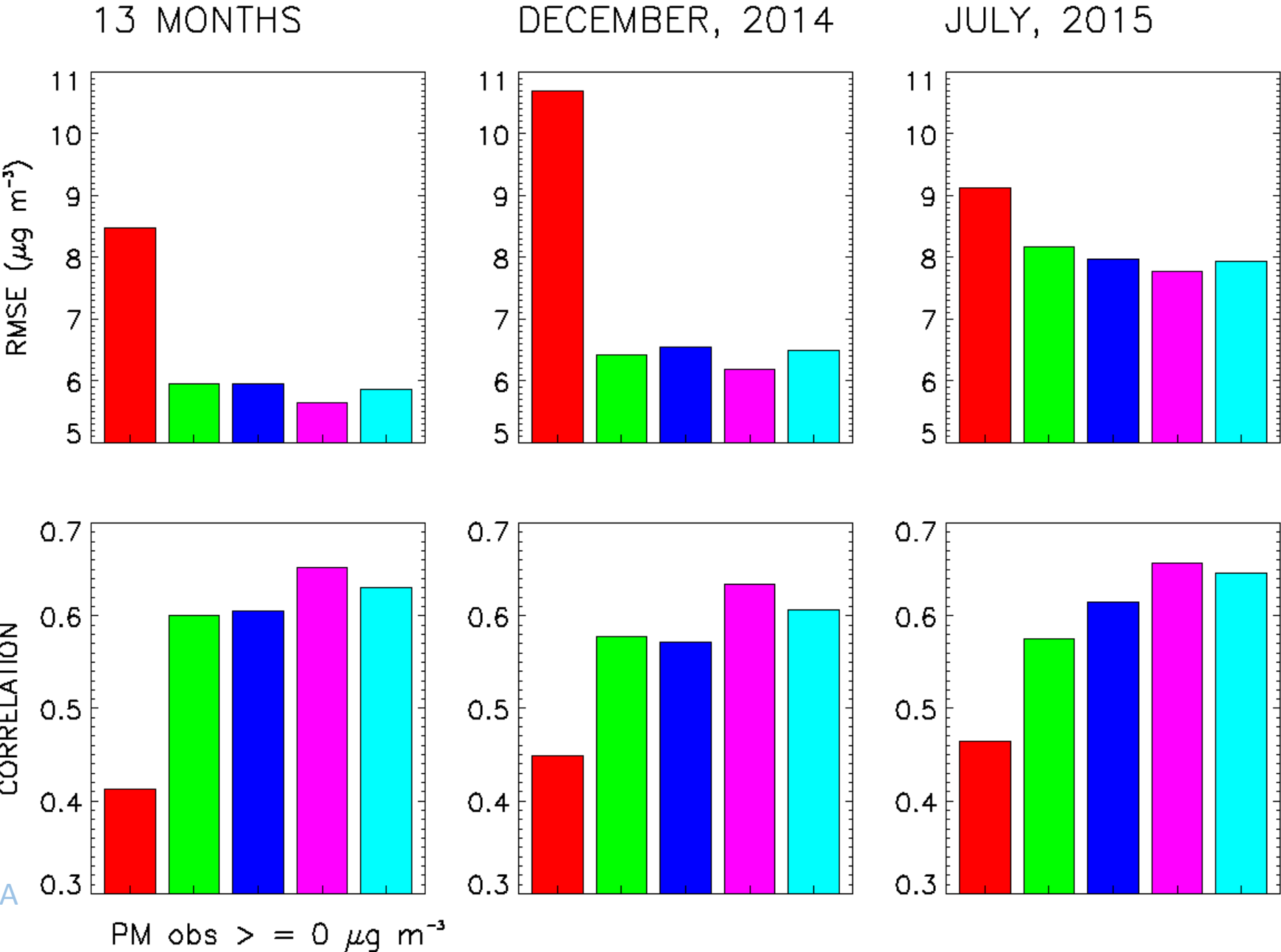
CMAQ

AN

KFAN

CIP_AN

CIP_KFAN



RMSE & Correlation

PM obs $> 20 \mu\text{g m}^{-3}$

CMAQ

AN

KFAN

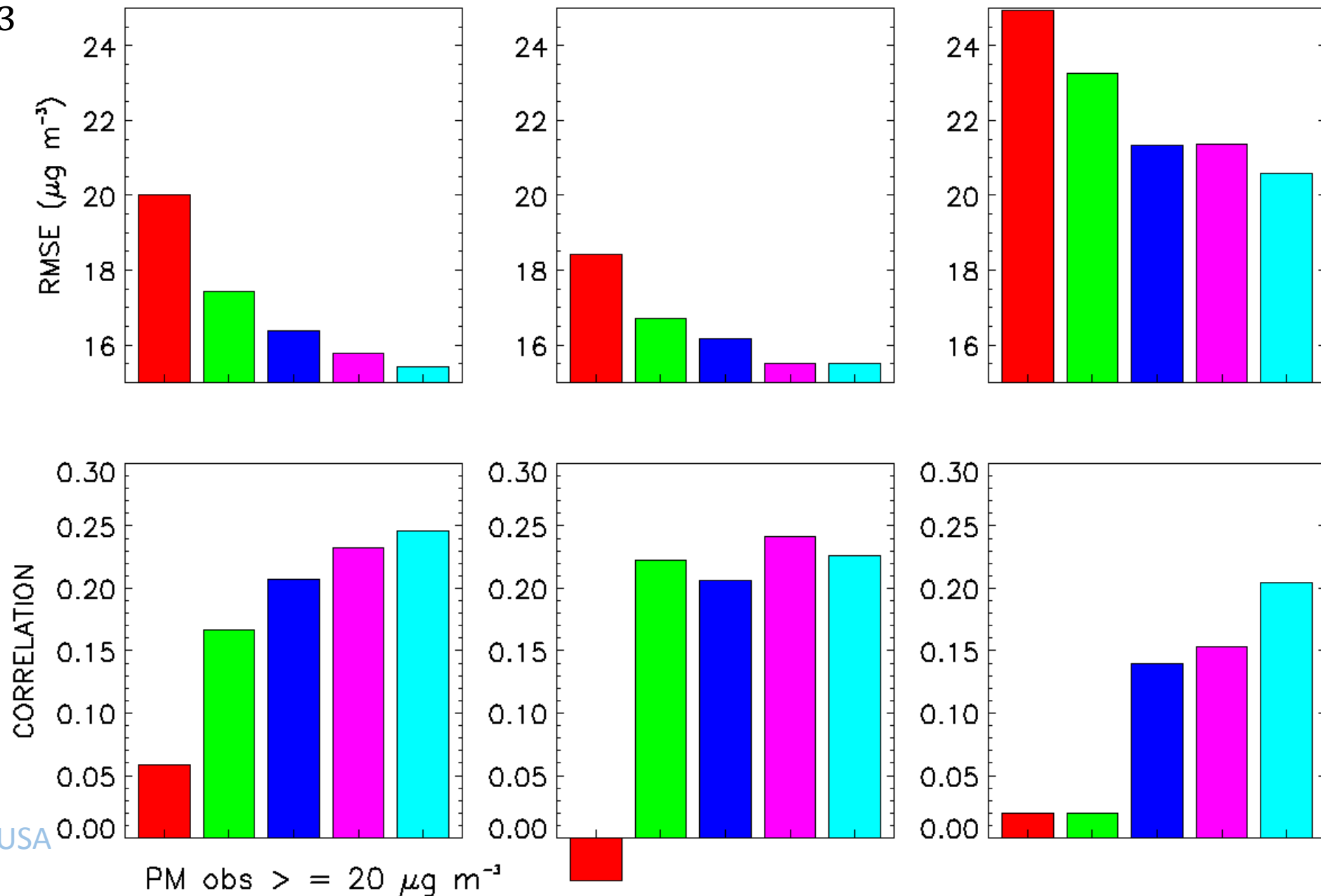
CIP_AN

CIP_KFAN

13 MONTHS

DECEMBER, 2014

JULY, 2015



Diurnal cycle
RMSE & Correlation
All values of obs PM

CMAQ

AN

KFAN

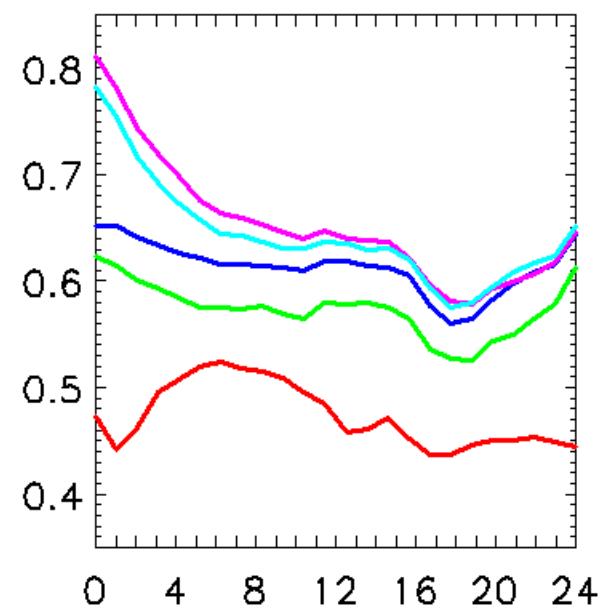
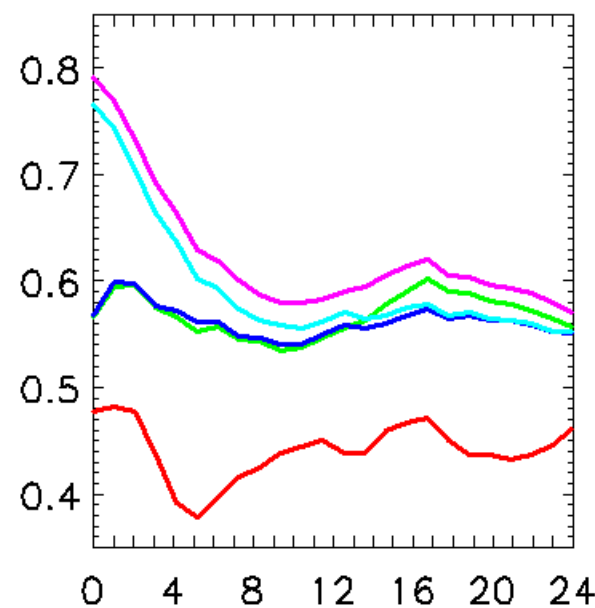
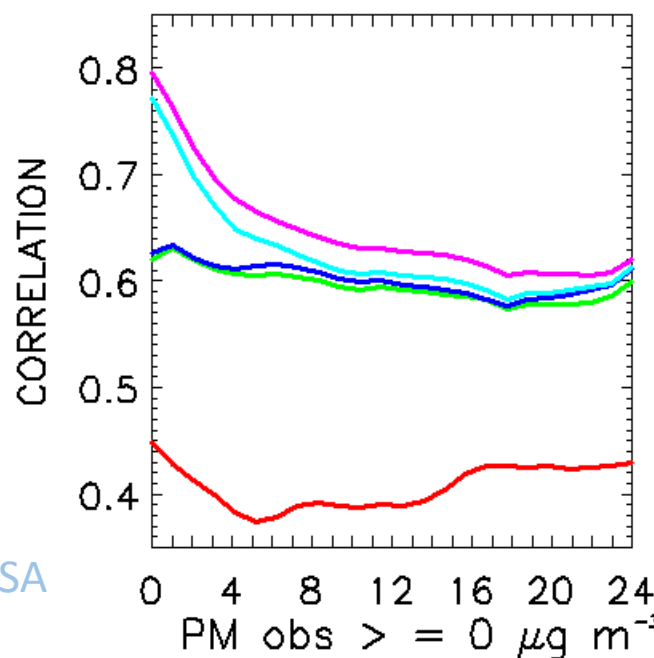
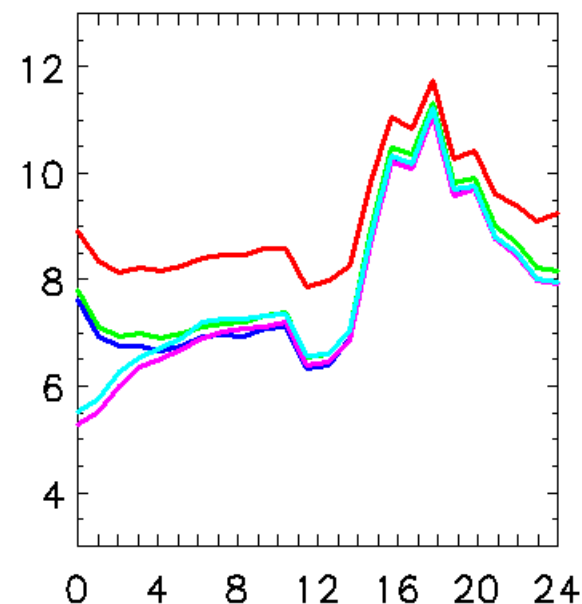
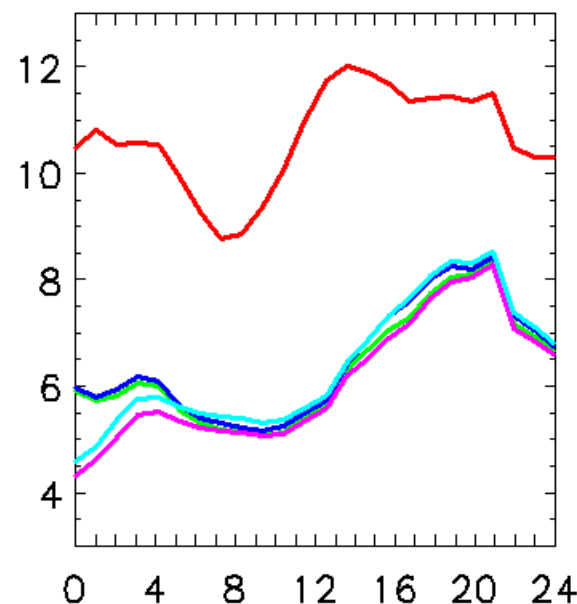
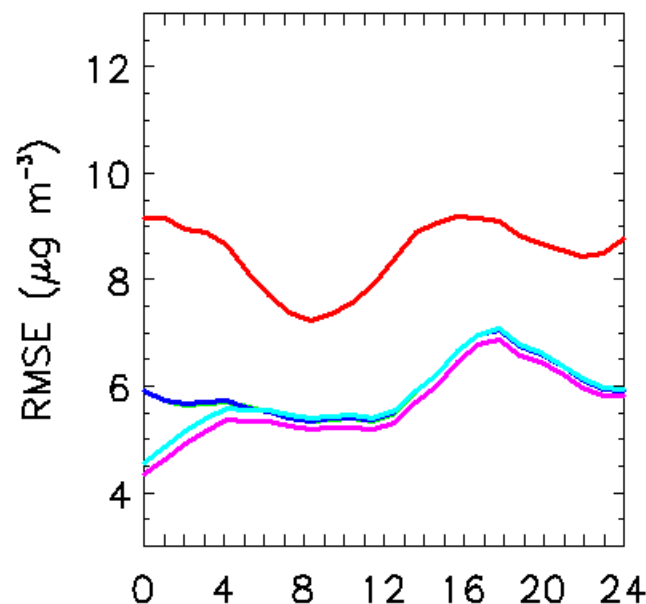
CIP_AN

CIP_KFAN

13 MONTHS

DECEMBER, 2014

JULY, 2015



Diurnal cycle
RMSE & Correlation
All values of obs PM

CMAQ

AN

KFAN

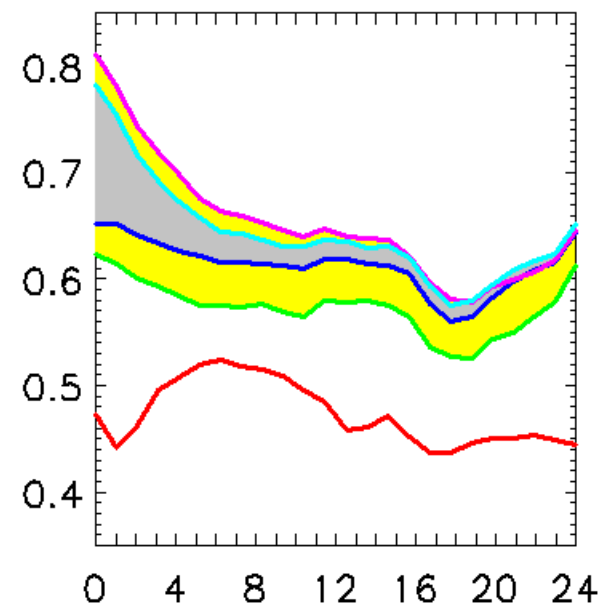
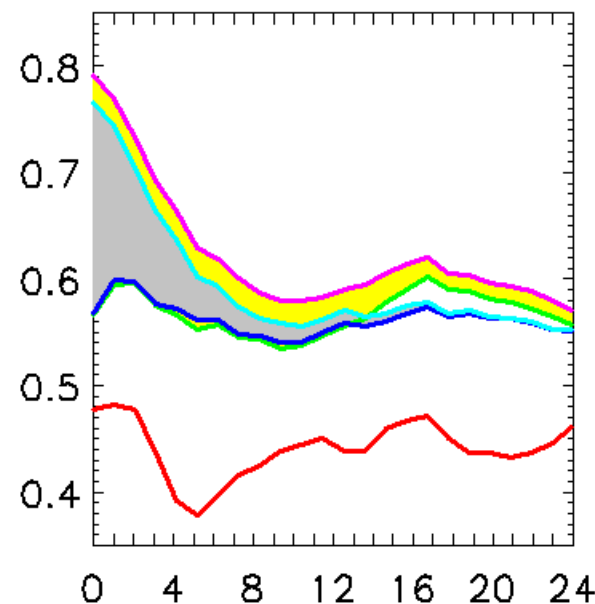
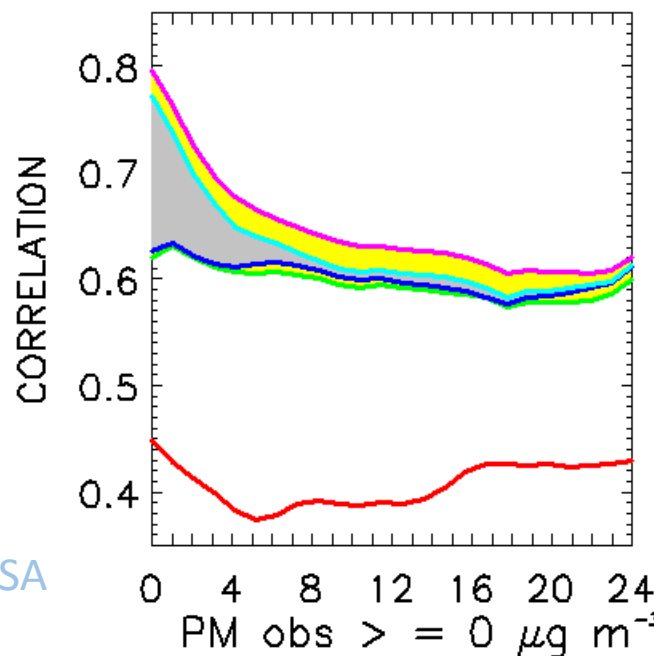
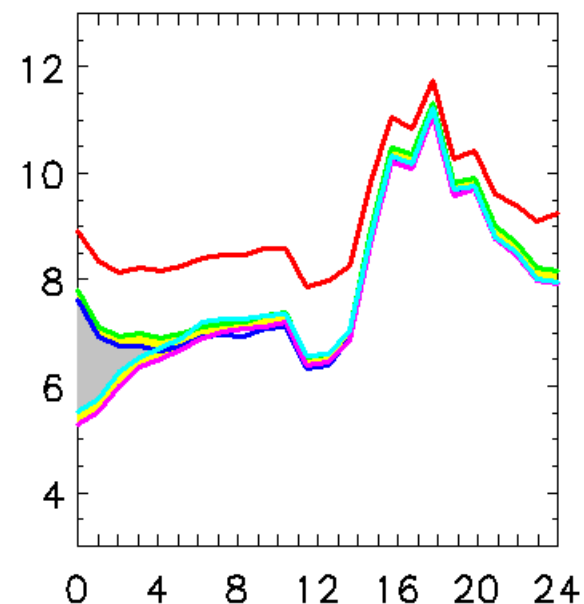
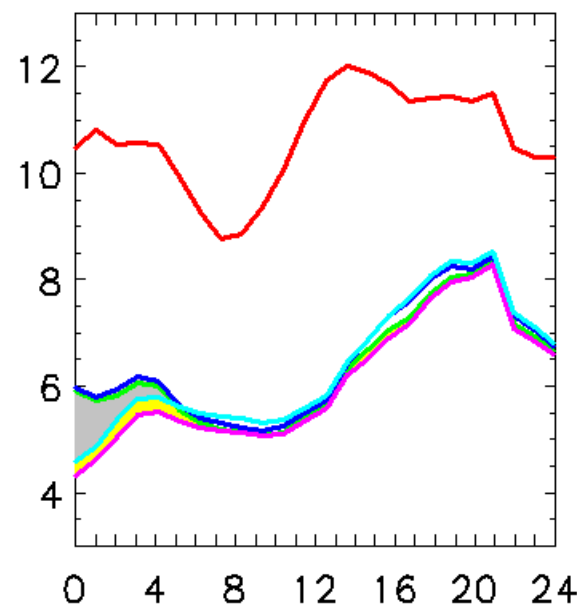
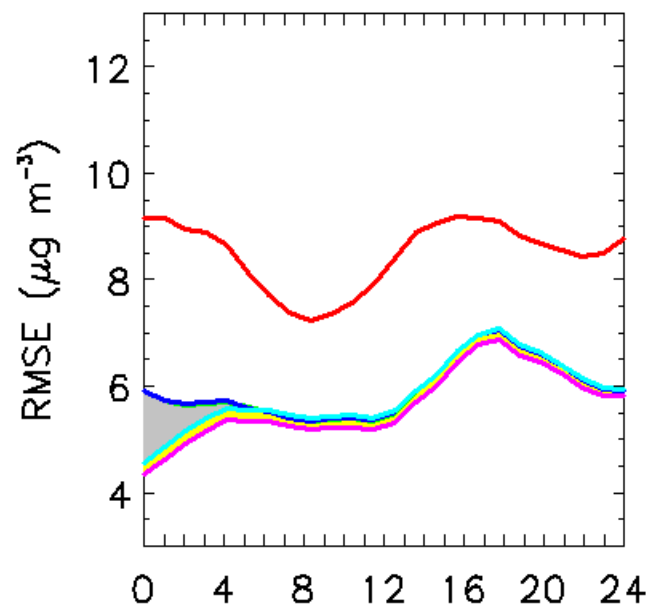
CIP_AN

CIP_KFAN

13 MONTHS

DECEMBER, 2014

JULY, 2015



Diurnal cycle
RMSE & Correlation
PM obs $> 20 \mu\text{g m}^{-3}$

CMAQ

AN

KFAN

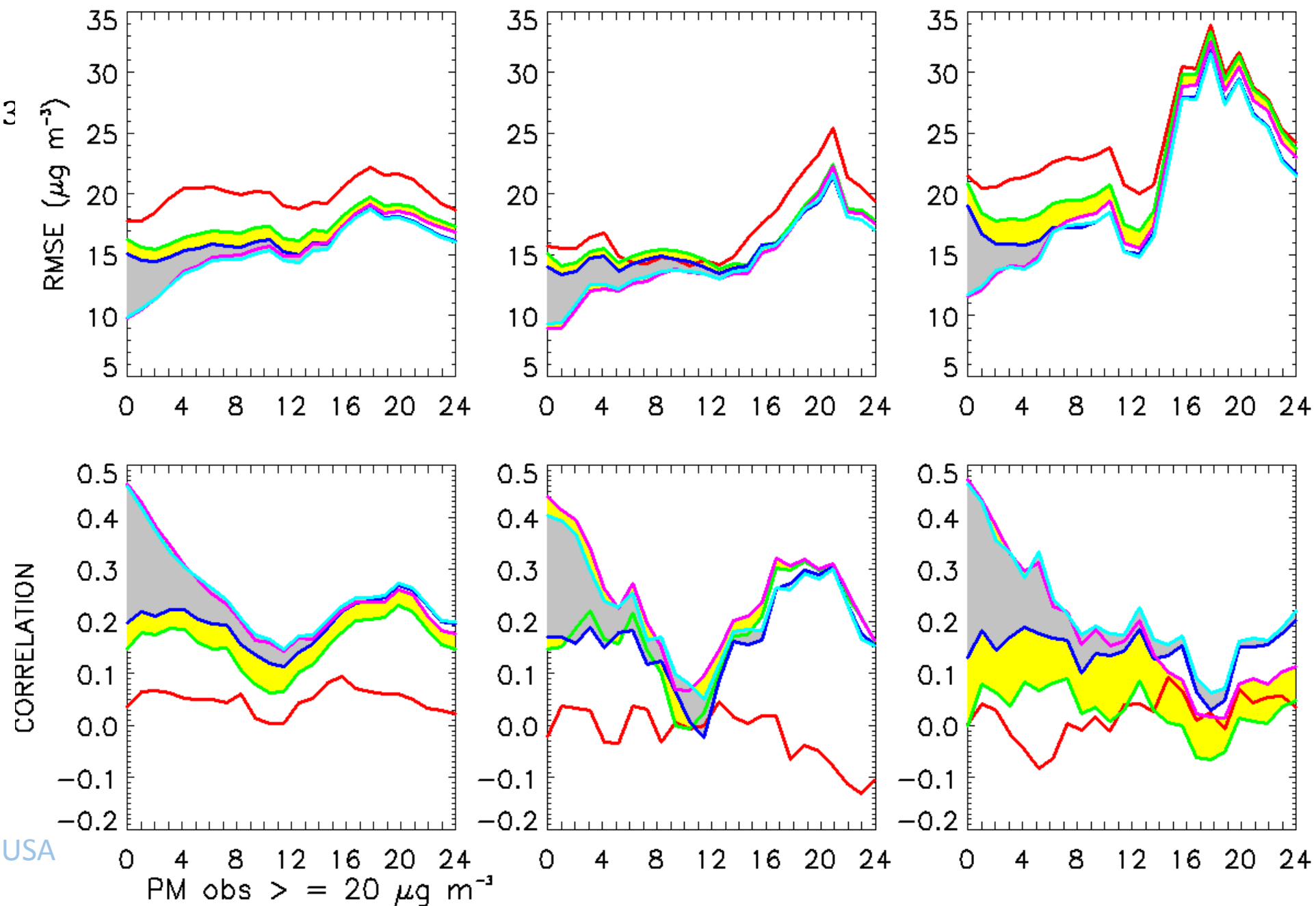
CIP_AN

CIP_KFAN

13 MONTHS

DECEMBER, 2014

JULY, 2015



CONCLUSIONS

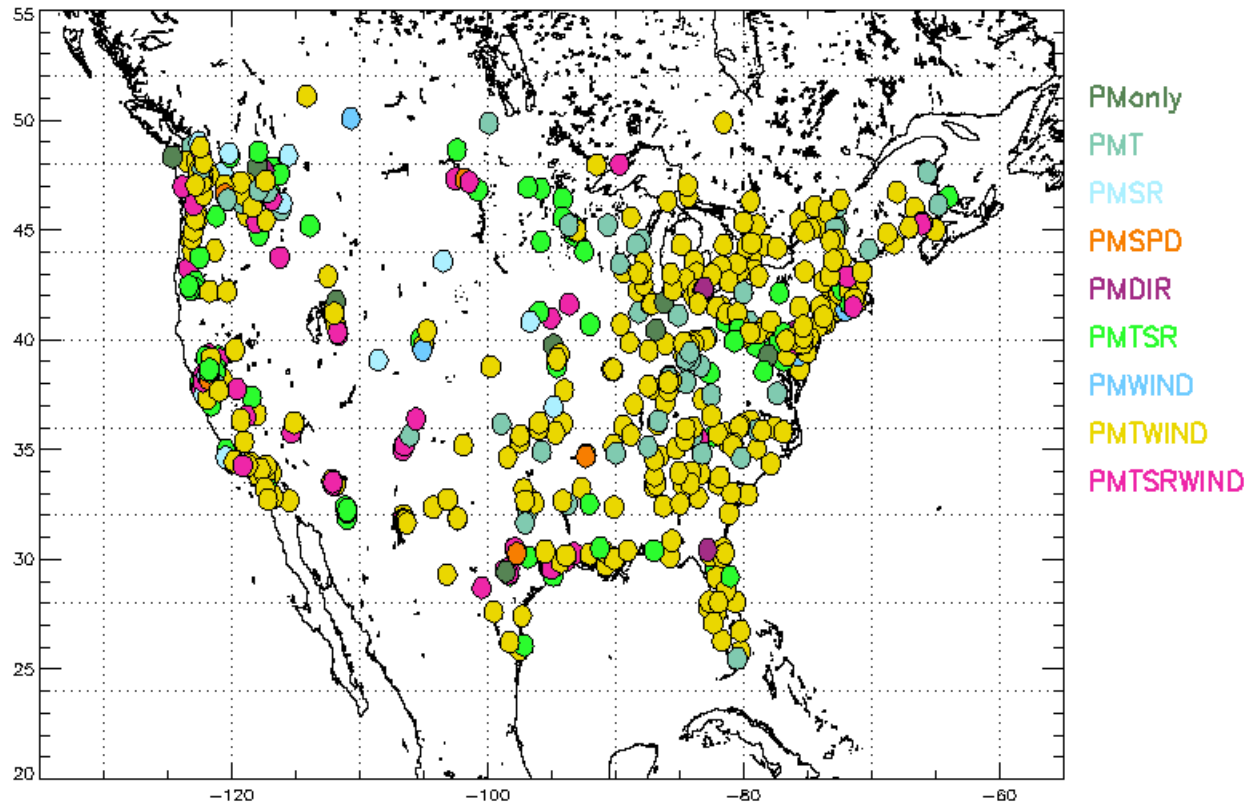
- The CMAQ model has been substantially improved since 2010. The winter months bias is reduced by half, but the smaller summer time bias is nearly doubled.
- The AN and KFAN bias-corrected models reduce the RMSE by ~30% and increase Correlation by ~50% over a 13-month period in 2014/2015.
- A new second-order CIP scheme, which utilizes the most recent OBS and (AN or KFAN) data, additionally reduces RMSE and increases Correlation by ~5-6% in average but largely for the first 10-12 hours of the forecast cycle.
- CIP_AN has better skill for lower observed PM, CIP_KFAN has better skill for high values of PM obs ($> 20 \mu\text{g m}^{-3}$).

THANKS

Optimal analog search variables:
from 9 sets of predictors the best set has the highest correlation with
observed data at each individual site in 13 months time period.

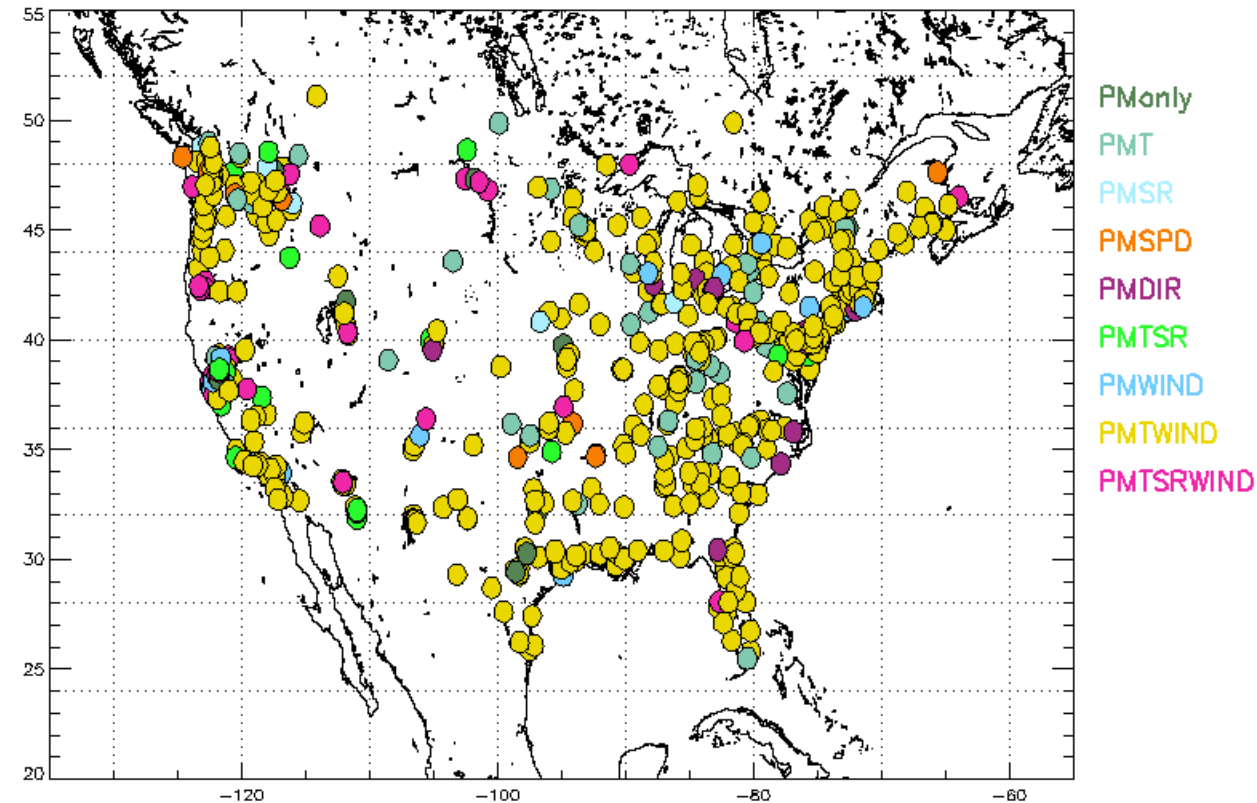
AN

PM_{2.5} JULY, 2014 – JULY, 2015

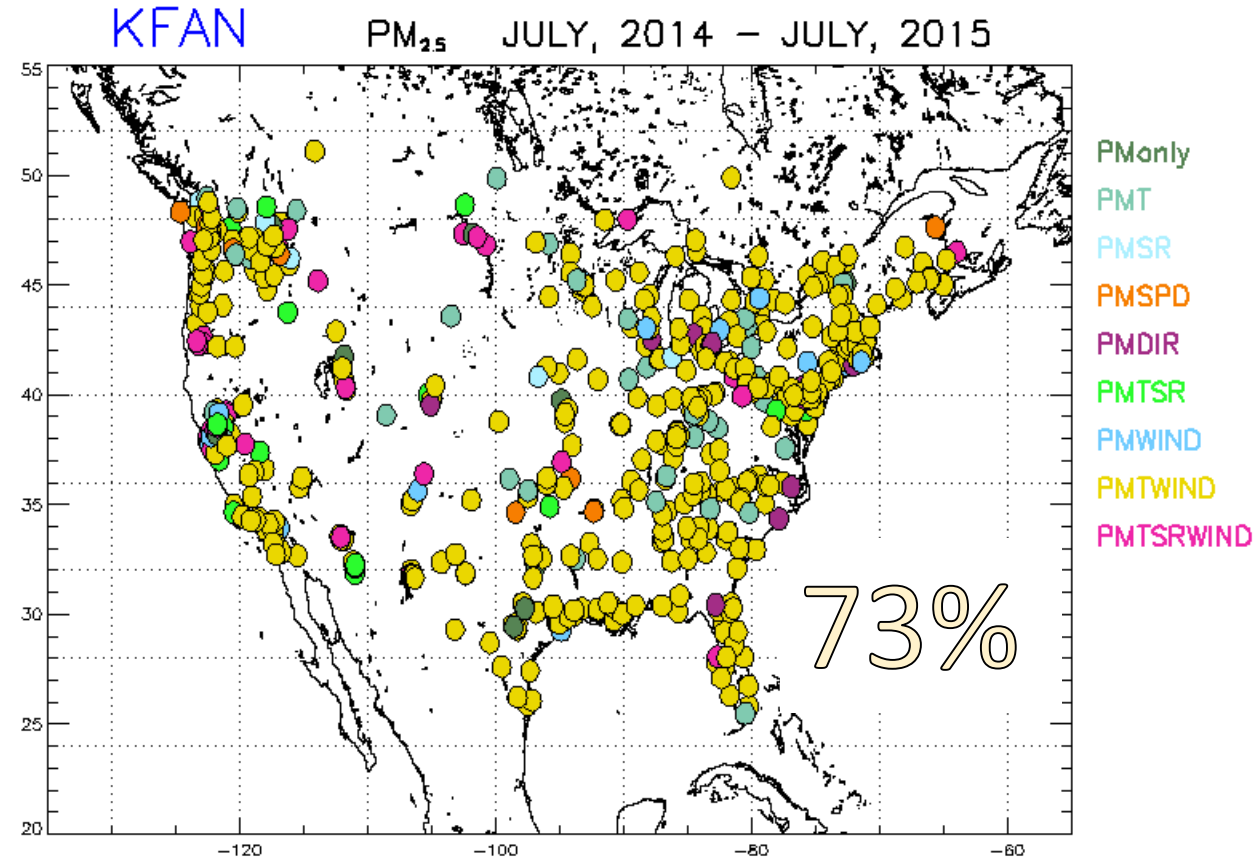
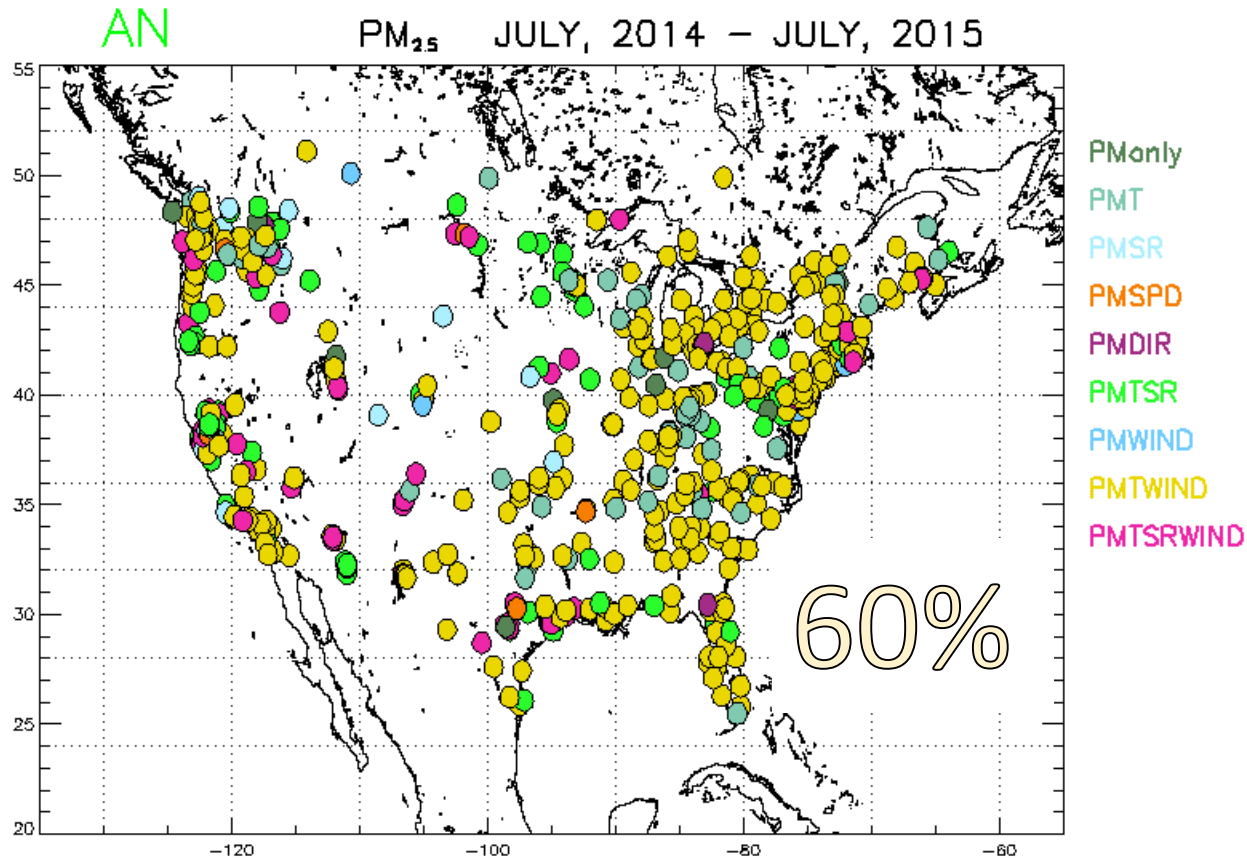


KFAN

PM_{2.5} JULY, 2014 – JULY, 2015



Different predictor sets:
from 9 sets of predictors the best set has the highest correlation with
observed data at each individual site in 13 months time period.



RMSE & Correlation

All values of obs PM

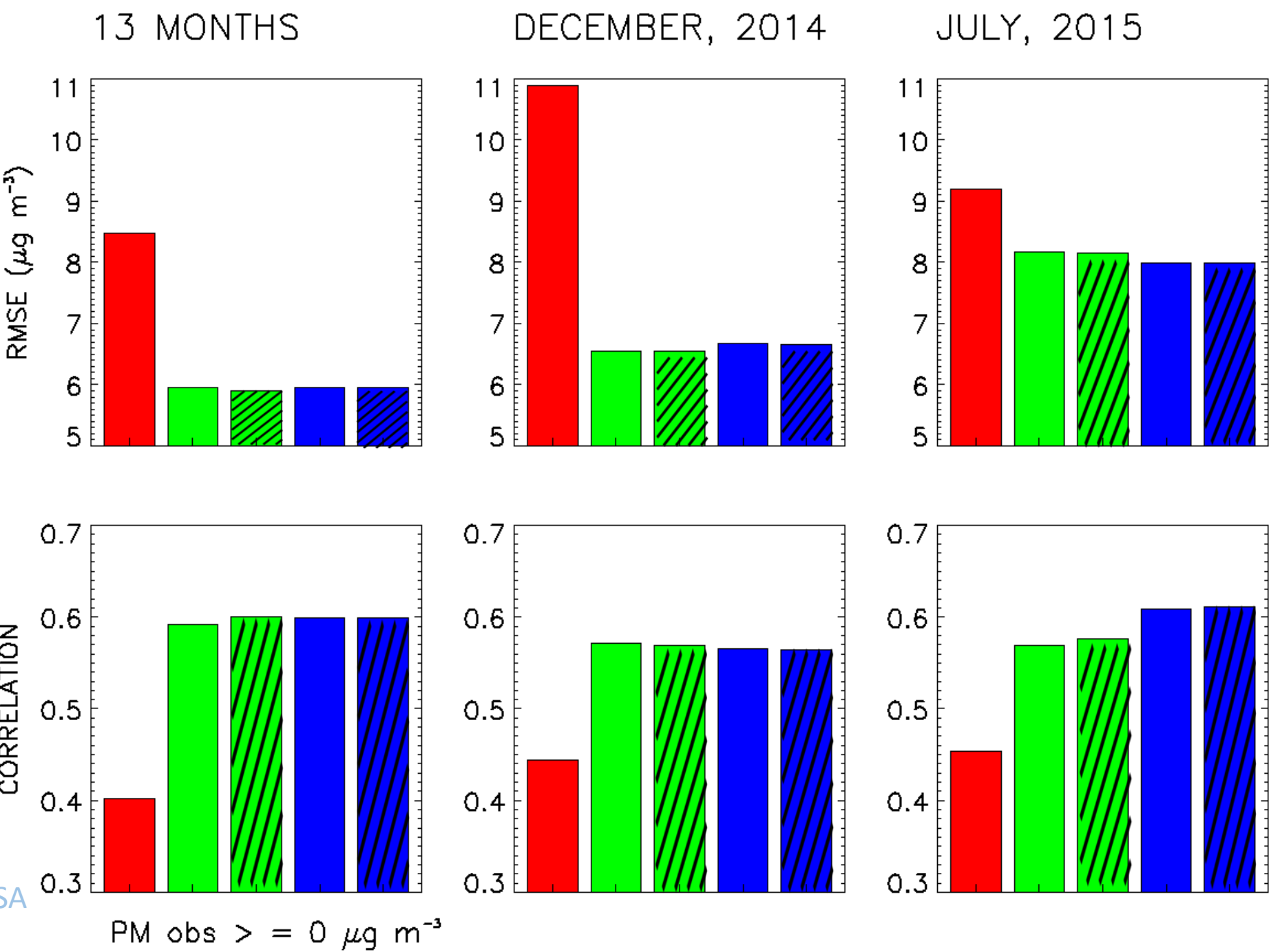
CMAQ

AN

KFAN

AN, KFAN from optimal
analog predictors are
hatched

7th IWAQFR, College Park, MD, USA
1-3 September, 2015



RMSE & Correlation

PM obs $> 20 \mu g m^{-3}$

CMAQ

AN

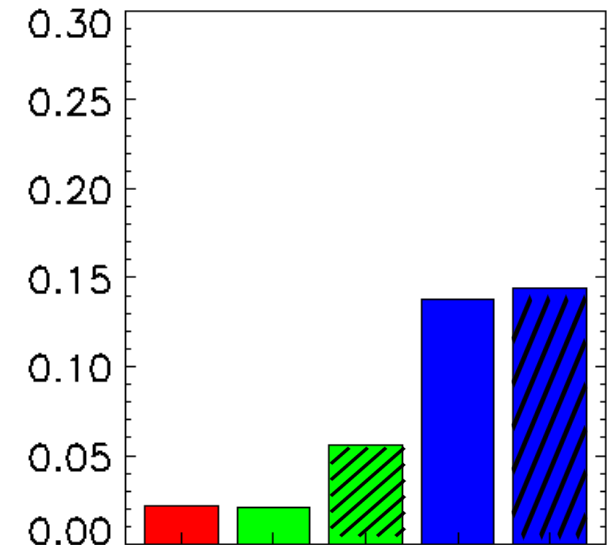
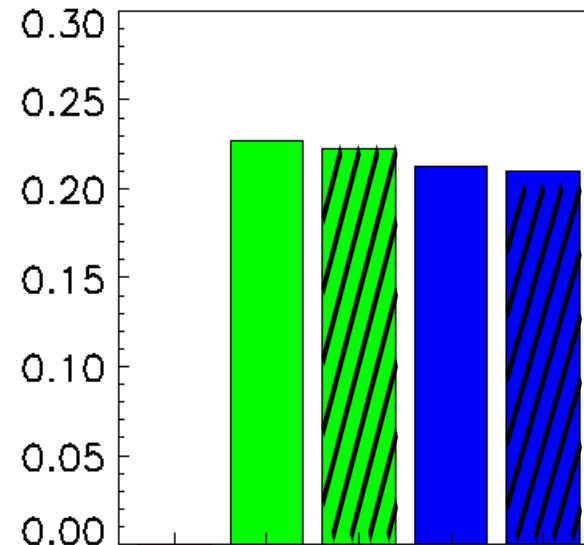
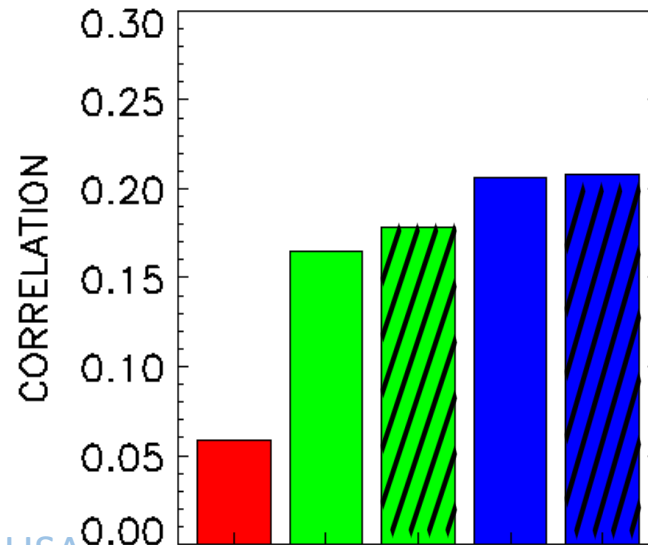
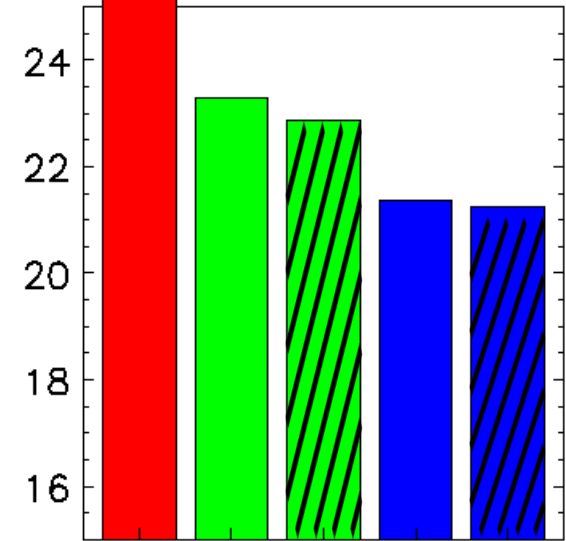
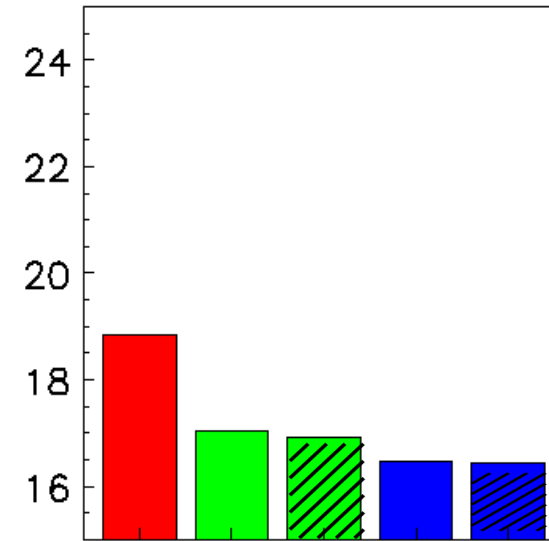
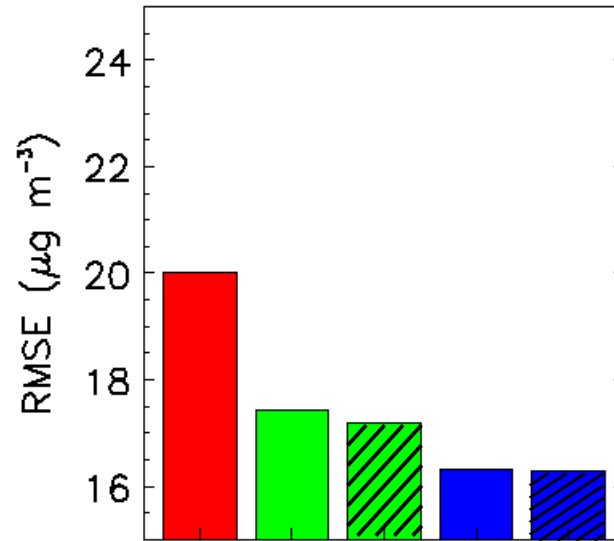
KFAN

AN, KFAN from optimal
analog predictors are
hatched

13 MONTHS

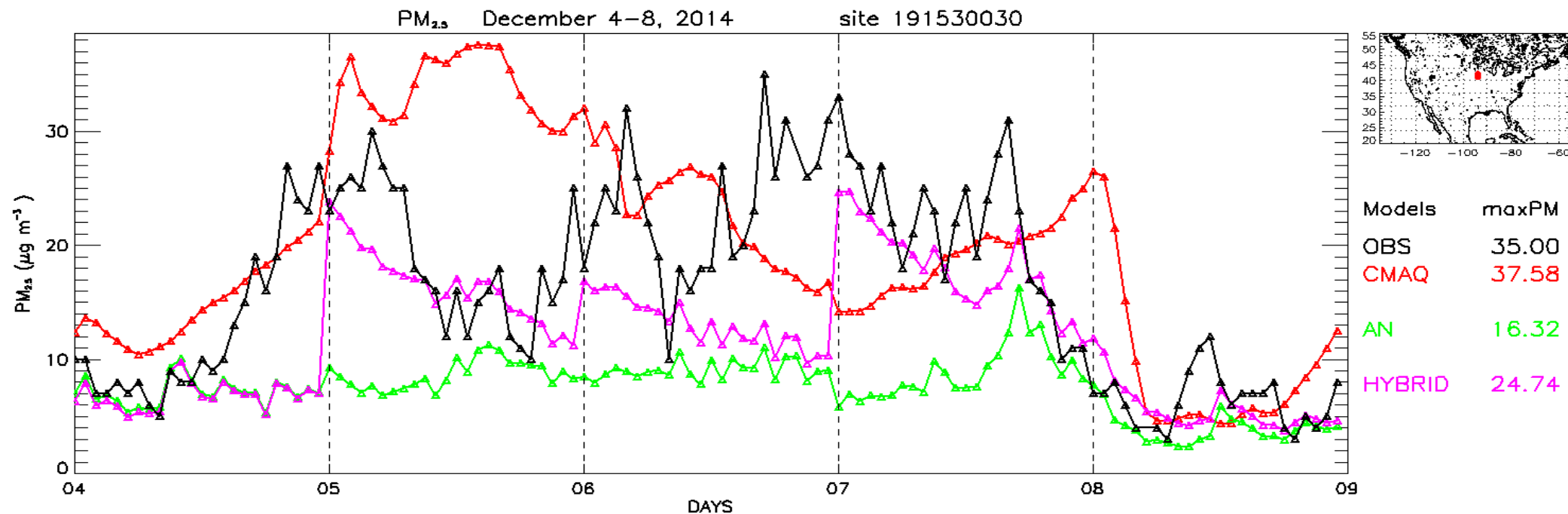
DECEMBER, 2014

JULY, 2015



PM obs $> = 20 \mu g m^{-3}$

Time Series
Hybrid AN Bias
Correction



Time Series
Hybrid KFAN Bias
Correction

